PREDICTIVE INDICATORS

SUMMER SCHOOL 2017

CONTENTS

- Definitions
- Business problem
- Technical questions
- Solution (Running example)
- Work in progress and future work

INDICATOR DEFINITION

Indicator

Included in dashboards monitoring the performance of organisations for decision-making purposes.

Measurements that quantify how much a goal is fulfilled

Two primary attributes: Focus and **TENSE**

Make optimisation adjustment in real time

	Lagging indicators	Predictive indicator
Reflection	What has already happened and what is currently happening in terms of goal fulfilment	What is likely to happen in the future in terms of goal fulfilment
Measure	Outcome performance	Future performance
Usage objective	Improve the present performance by studying the past	Increase the chance of improving a certain goal fulfilment by studying the future
Insight	Descriptive insight	Foreward-Looking insight
Action	Corrective action	Proactive action

BUSINESS PROBLEMS OF ADAPTING PREDICTIVE INDICATORS

How to measure the impact of predictive indicators on business goals?

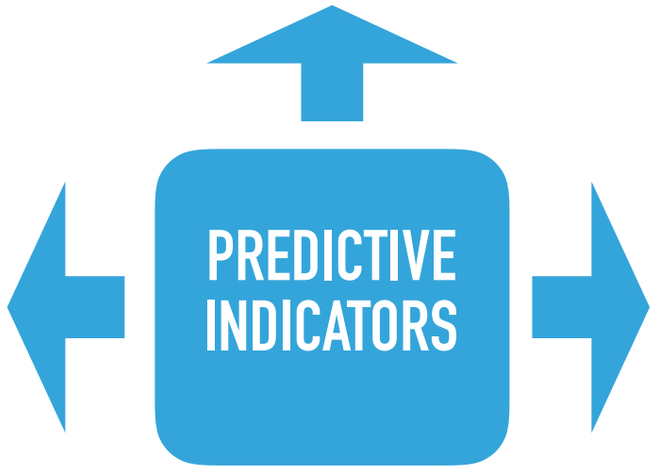
Why and where in organisations to use predictive indicators?

How to measure a predictive indicator? what are the main driver? what computation technique to perform?

TECHNICAL QUESTIONS

Predictive indicator effectiveness

- How to capture the interaction of predictive indicators and subsequent proactive actions with lagging indicators to quantify their effectiveness in regards to goal fulfilment



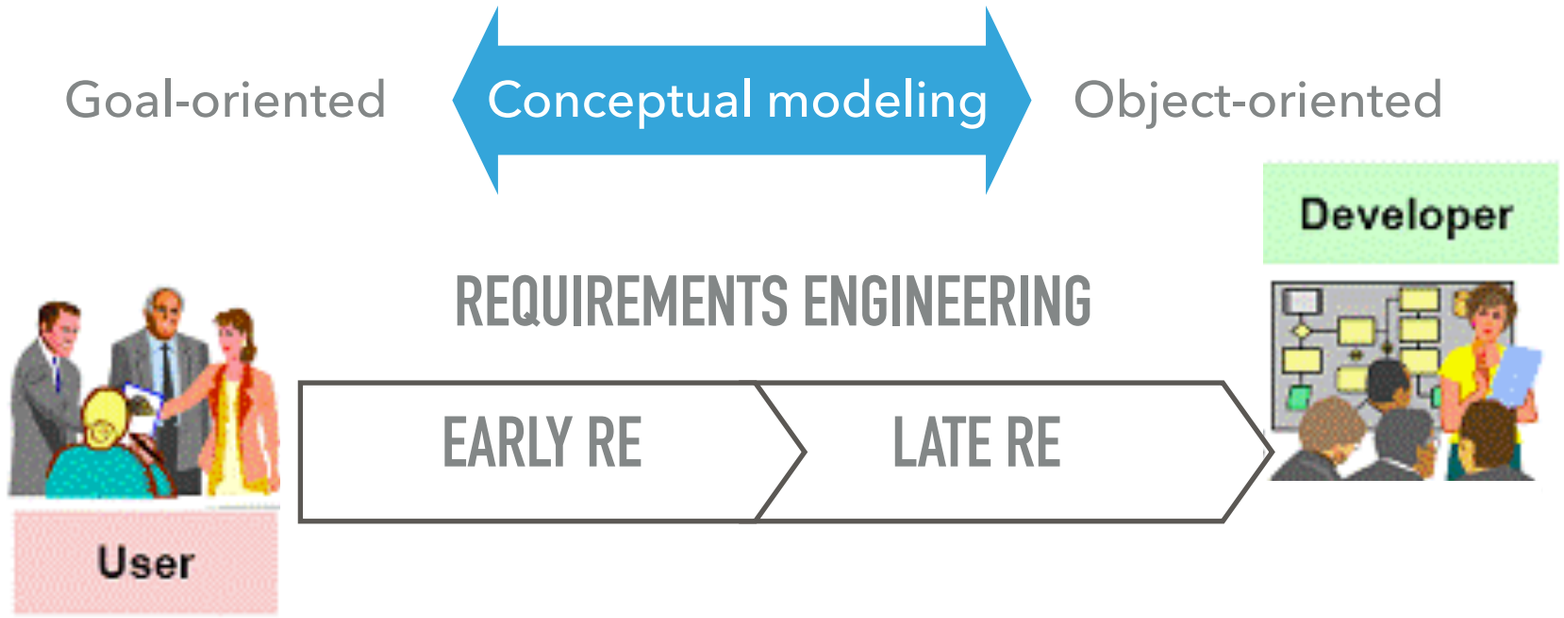
Predictive indicator alignment:

- How to enhance the descriptive insight provided by lagging indicators into an actionable insight by predictive indicators in monitoring systems

Predictive indicator measurement:

- How to be able to make analytics design choices to measure a predictive indicator such as what are the available prediction strategies? what are the potential algorithms and data asset to focus on?

CONCEPTUAL MODELLING

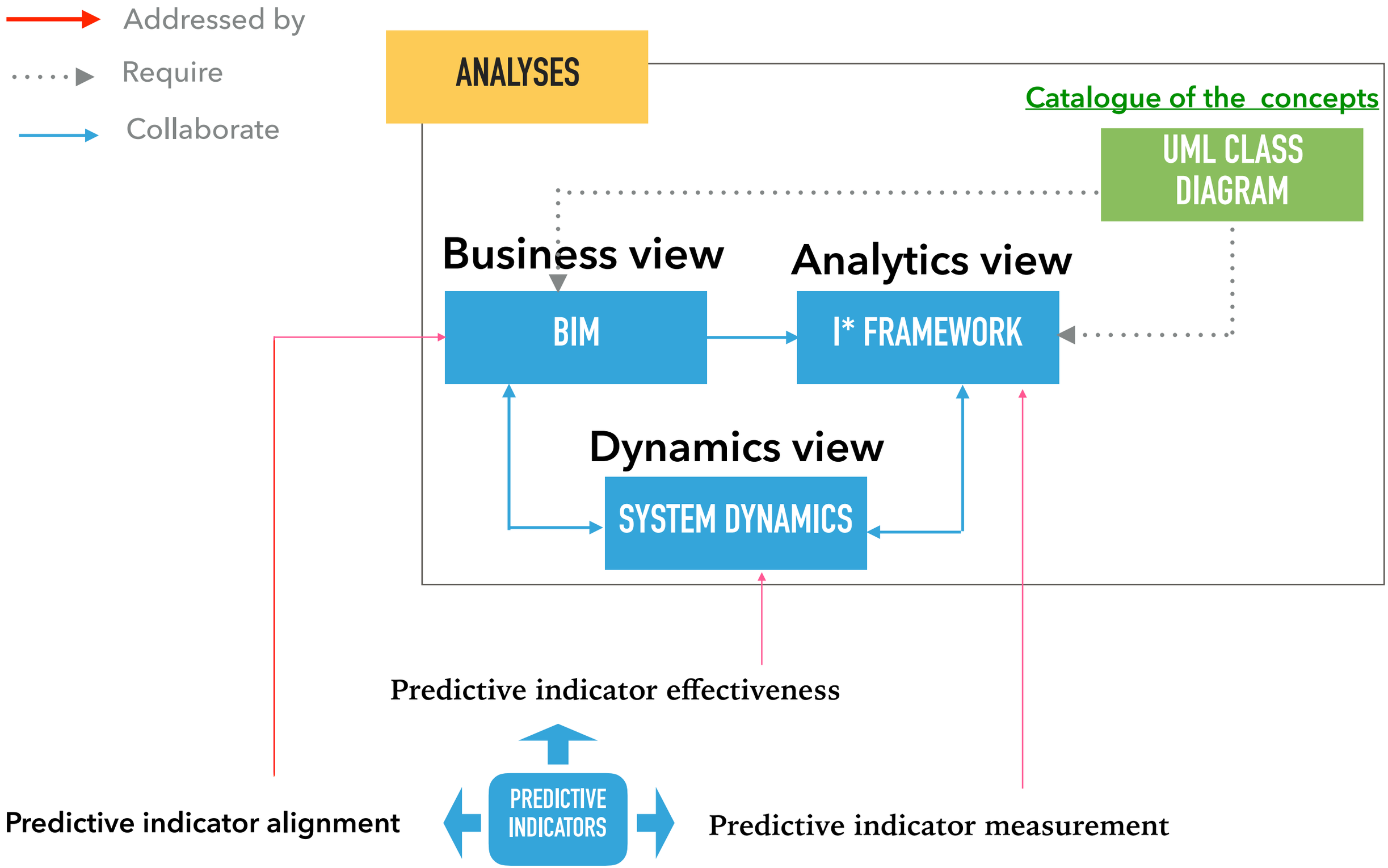


- Early RE

– Focus on identifying problems

– Exploring system solutions and alternatives

PROPOSED CONCEPTUAL FRAMEWORK

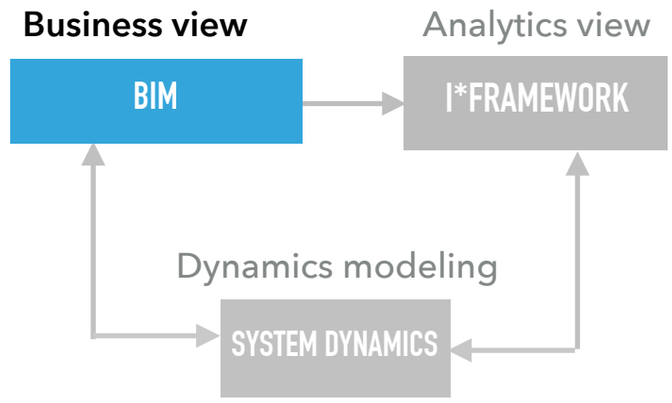


BUSINESS VIEW

Systematically transforms the descriptive insight provided by a set of indicators to an actionable insight using a predictive indicator.

BIM LANGUAGE

An enterprise modelling approach for monitoring the performance



BIM LANGUAGE

Offer a goal model involving concepts familiar to business, that can be connected to enterprise data, by which a **business viewpoint of enterprise data** is represented

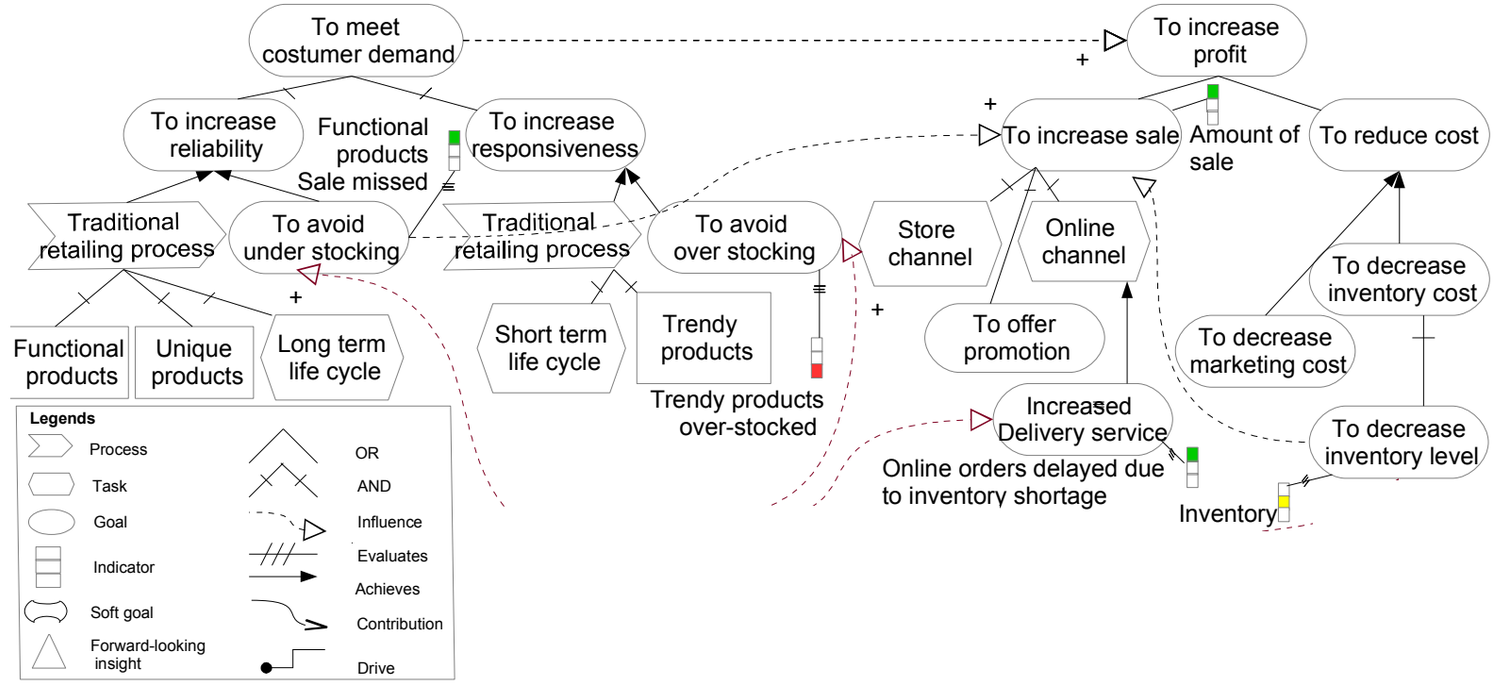
Enterprise modelling with BIM involves:

- Capturing the business strategy and then working in a top-down fashion by decomposing the strategy
- Associating indicators to gaols to evaluate fulfilment of goals
- Linking indicators to backend data sources to supply the current value of an indicator which is compared against a target, threshold and worst value

A RETAILER IN THE FASHION INDUSTRY

Two main retailing processes:

- Functional products sold through traditional process ,
- Trendy products sold through fast fashion process



BUSINESS VIEW USING BIM (INPUT/OUTPUT)

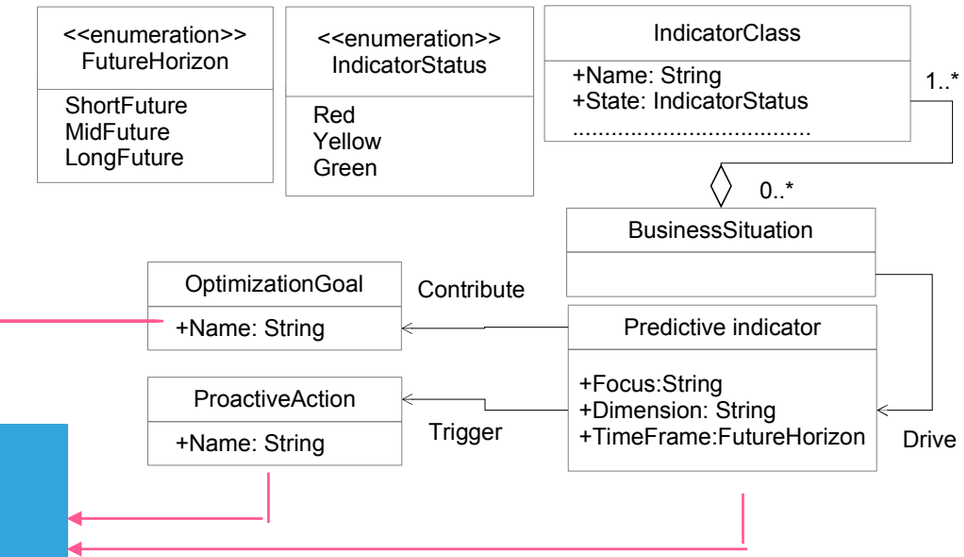
Business analyst

INSIGHT ANALYSIS

Capture new concepts related to predictive indicator

Gain descriptive insight from lagging indicators

BIM LANGUAGE EXTENDED WITH NEW CONCEPTS



An enterprise model incorporating predictive indicators and corresponding business concepts

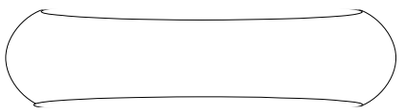
Benefits

- Improved communication among decision makers
- Formulate the cognitive model of the enterprise
- Help to make sense of predictive indicators within the organisational context

BUSINESS VIEW USING BIM (NEW CONCEPTS)

DEFINITION OF NEW CONCEPTS

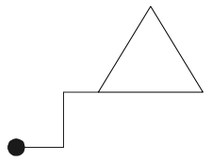
- **Optimisation goal:** represents an intention to make a balance among a set of goals related to an area of the business domain that are possibly in conflict.



- **Indicator state:** illustrates the performance level of an indicator at a given time and represents the fulfilment status of the associating goal.

- **Business situation:** a set of meaningful states captured at a given time by one or a group of indicators which belong to the goals influenced by the optimisation goals.

- **Predictive indicator:** contributes to satisfy an optimisation goal by studying the future. The focus, coordinates, and time horizon of the future to be studied is specified.



- **Proactive action:** serves to be prepared in advance to increases the fulfilment chance of deficient goals.

BUSINESS VIEW (ANALYSIS/ CONCEPTS)

INSIGHT ANALYSIS

Identify an "**Optimisation goal**" and capture it in the BIM

↓

Identify the influence to other business goals

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Sense from the indicators of influenced goals at run time

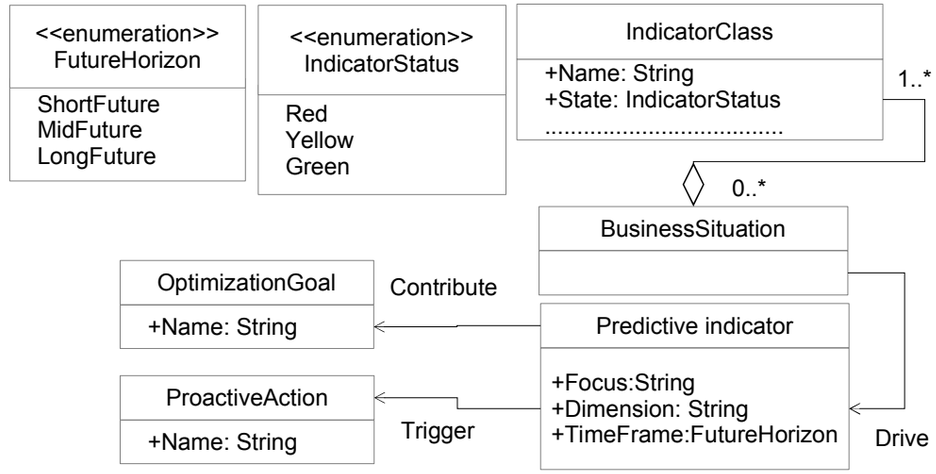
↓

Identify a **"Business situation"** composed of a meaningful various combinations of the indicator states

↓

Translate each business situation into the "**Predictive indicator**" which triggers a **right "proactive action"** in terms of goal fulfilment

UML CLASS DIAGRAM



BIM LANGUAGE

OPTIMISE THE INVENTORY REPLENISHMENT BY PREDICTING THE CUSTOMER DEMAND

Case study

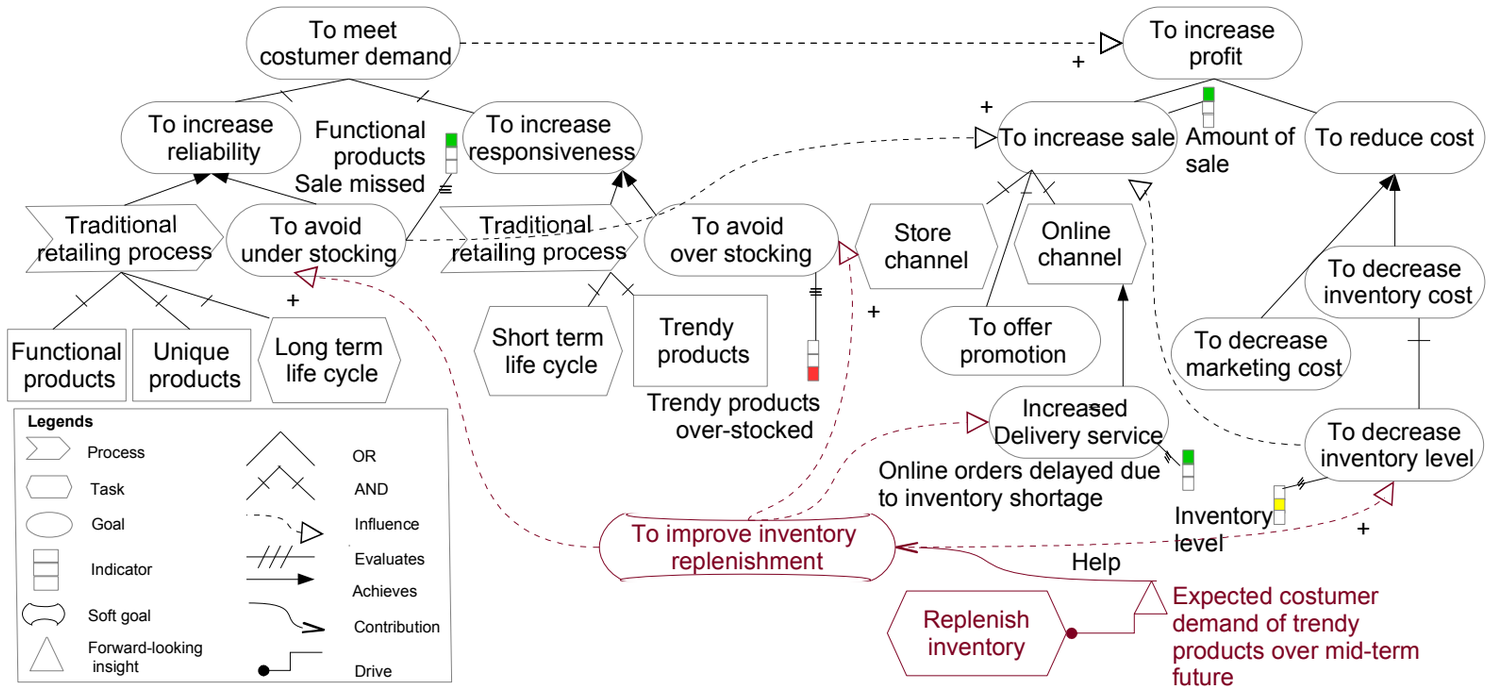
OPTIMISE THE INVENTORY REPLENISHMENT PROCESS BY PREDICTING THE CUSTOMER DEMAND

- A retailer in the fashion industry orders a certain amount of products from manufacturers and put them in the inventory to meet consumer demands.

MAIN ISSUES TO OPTIMISING THE INVENTORY REPLENISHMENT

- The inventory replenishment influences various business goals targeting different products and business processes of the retailer.
- The retailer undergoes various situations in terms of goal fulfilment as internal and external business environment changes over time.
- The frequency to replenish the products are also not the same.
- The stocking policies also varying from one product to another, i.e., under-stocking is allowed for trendy products, while it is not for the functional products.

BUSINESS VIEW (RUNNING EXAMPLE)



Optimisation goal: To improve inventory replenishment (influenced goals: To avoid under stocking, to avoid overstocking, Increased delivery service, To decrease inventory level)

Business situation: [green:Amount of sale, yellow: Inventory level, red:Trendy products overstocked]

Predictive indicator: The expected consumer demand of trendy products over the mid-term future horizon.

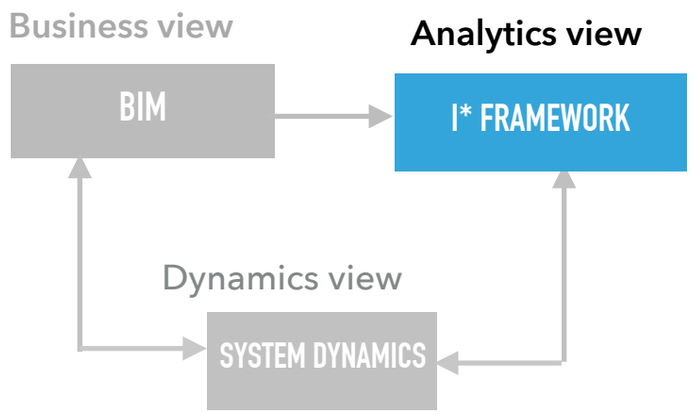
Proactive action: Replenish inventory

ANALYTICS VIEW

Systematically captures the analytics design alternatives from data and computational perspective to measure a predictive indicator

I* FRAMEWORK

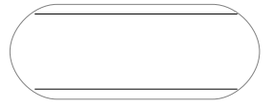
A modelling language suitable for early RE to understand the problem domain.



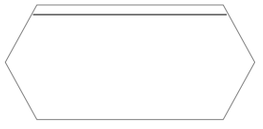
ANALYTICS VIEW RELATED CONCEPTS

- **Prediction top goal:** an intention to predict the future value of an object of interest in the business domain

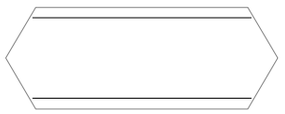
- **Prediction strategy:** an intention to determine the drivers in the business domain or its environment to forecast (looking for the possible objects to manipulate, or control that could relate to the object of interest to forecast)



- **Exploration task:** the steps of a procedure to drive the forecast of the object of interest from possible objects in the business domain and its environment.



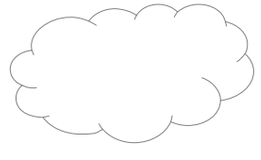
- **Computation task:** the computation aspect of a an analytics task which denotes a mining technique. It is assigned a machine learning technique including: clustering, classification, pattern discovery, etc.



- **Algorithm:** is an analytics task that represents the machine understandable aspect of a computation task.

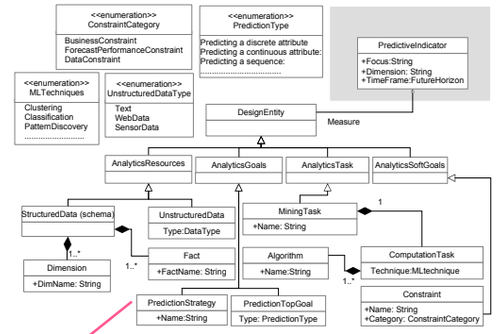
- **Variable:** is an analytics resource that deals with the data involved to perform a computation task. Data might be structured or unstructured.

- **Constraint:** is an analytics soft-goal representing conditions that needs to be taken into account when selecting an alternative among analytics goals, tasks and resources.



ANALYTICS VIEW USING THE I*FRAMEWORK

BUSINESS VIEW



Predictive indicator

ANALYTICS ANALYSIS

Business analysts

Analytics-related concepts

I* FRAMEWORK EXTENDED WITH NEW CONCEPTS

A goal model capturing a set of alternatives to design the analytics for measuring a predictive indicator from data and computational perspective and trade-offs to select each alternatives

Benefits

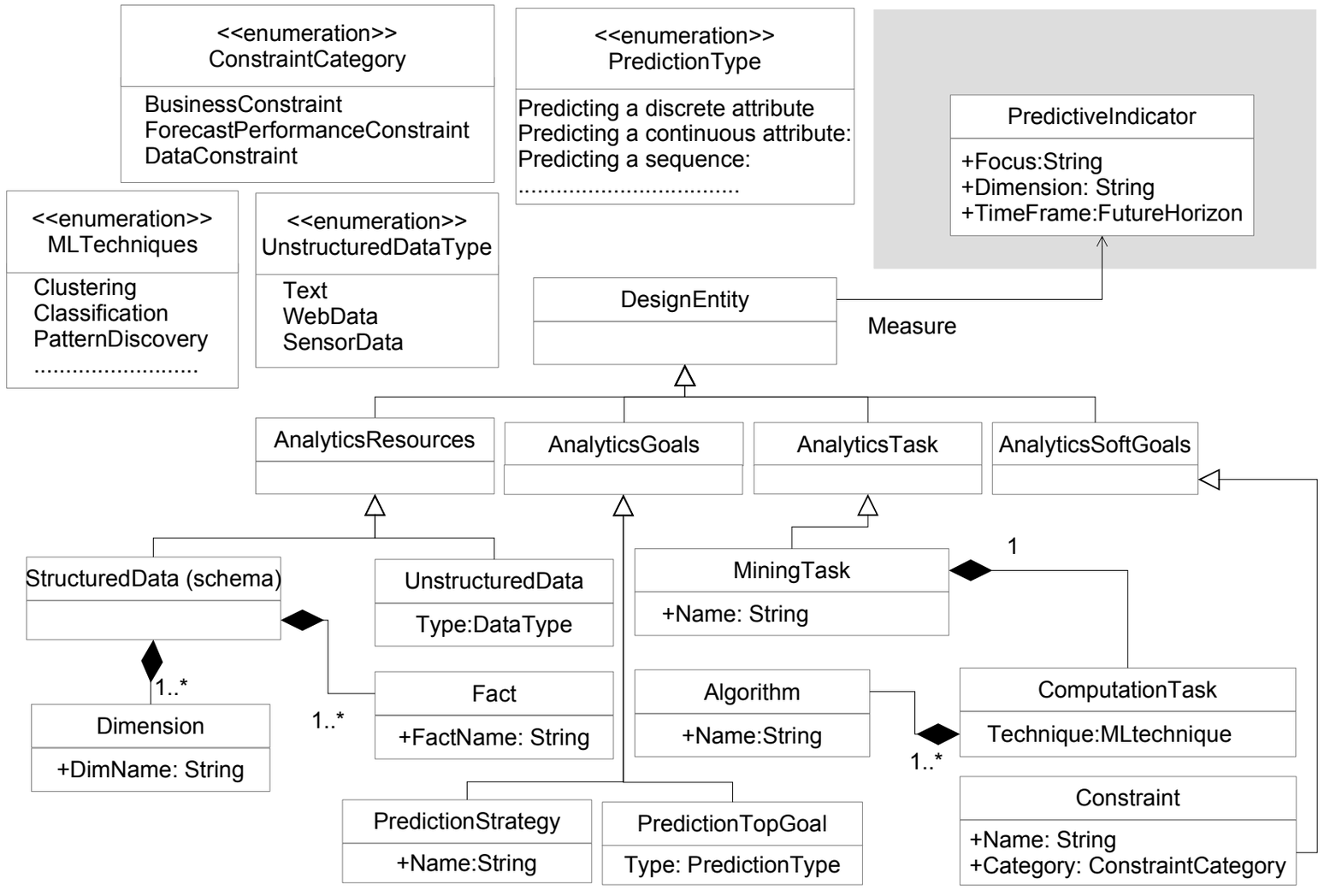
- Helps to bring relevant analytics knowledge to the attention of the decision maker to use and re-use
- Help to understand the analytics domain in business level

ANALYTICS VIEW

ANALYTICS ANALYSIS

- GOAL ANLYSIS
- TASK ANALYSIS
- RESOURCE ANALYSIS
- SOFTGOAL ANALYSIS

UML CLASS DIAGRAM



ANALYTICS ANALYSIS

Capture a "**Prediction top goal"** for the predictive indicator derived from the business view and identify the **"Prediction type"** as the main attribute

↓

Decompose the prediction top goal into **"Prediction strategy"**

↓

Decompose further prediction goals until a certain driver is determined to forecast based on.

↓

Analyse the lowest level leaf goal to identify **"Exploration tasks"** that captures an object in the domain or its environment to analyse to achieve analytics goals

↓

Decomposed the tasks until a **"Computation task"** is identified by which the computation aspect of the task by the means of a mining technique is determined.

↓

Identify the **"Algorithms"** which are the machine understandable property of the computation task

↓

Identify "variable" for each exploration task that represents the data set involved to perform an exploration task.

↓

Decompose **"Variable"** when it is needed until certain coordinates to perform the computation is identified. For variables accessed from a source of unstructured data or data warehouse, identify the attribute of the "**Data type"** and **"fact/dimension",** respectively.

↓

Identify **"constraints"** that guide (or restricts) the selection among alternatives of goals, tasks, and resources. Then identify the type of of business constraint, data, and computation constraints.

ANALYTICS VIEW (RUNNING EXAMPLE)

- **Prediction top goal:**

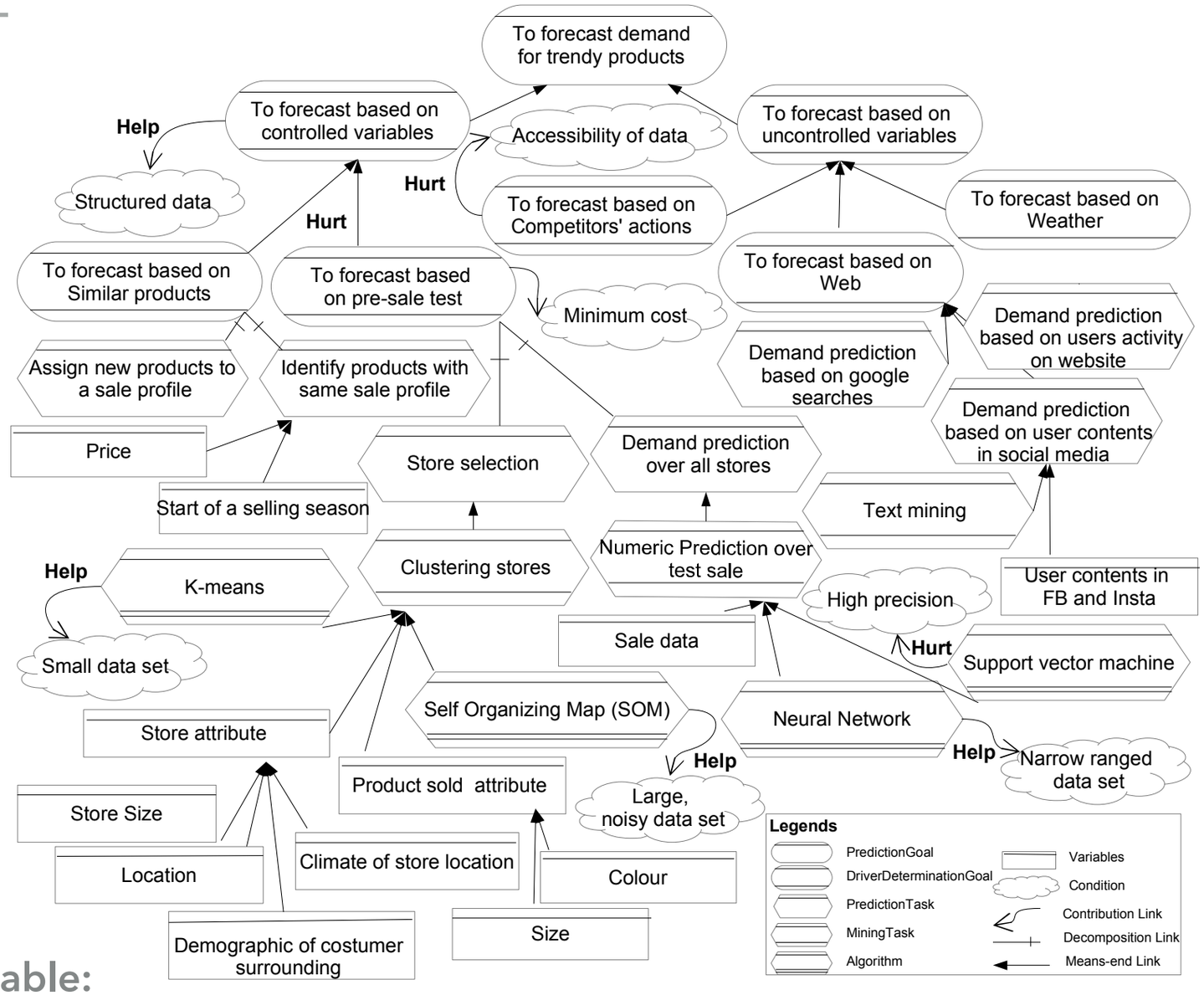
To forecast demand for trendy product over mid-term future horizon

- **Prediction strategy:**
  - To forecast based on controlled variables

    -To forecast based on similar products

    -To forecast based on pre-sale test

- **Exploration task:**
  - Store selection
  - Demand prediction over all stores
- **Computation task:**
  - Clustering stores
- **Algorithm:**
  - K-means



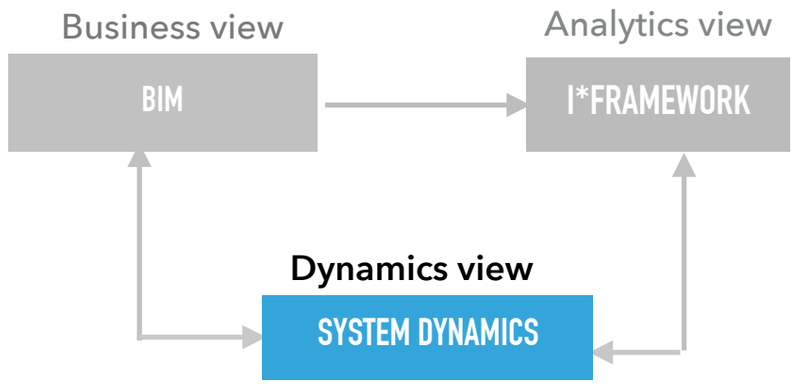
- **Variable:**
  - Store attribute
  - Product sold attribute
- **Constraint:**
  - Minimum cost

DYNAMICS VIEW

To examine how different analytics strategy will influence business strategies

SYSTEM DYNAMICS

An approach for understanding and modelling the dynamics and behaviour of complex systems over time.



SYSTEM DYNAMICS IN GENERAL

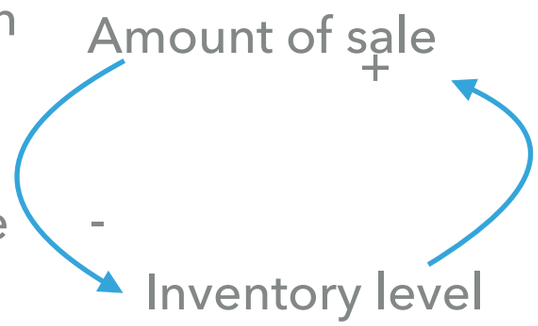
Modelling process:

1. **Identify the problem**
   - Identify variables
2. **Develop a hypothesis**
   - Casual loop diagram
   - Stock and flow diagram
3. **Validate the hypothesis**
   - Simulation model
4. **Test policy alternatives**
   - Identify decision policies: Decisions that organisation makes to solve the problem:

Casual Loop Diagram:

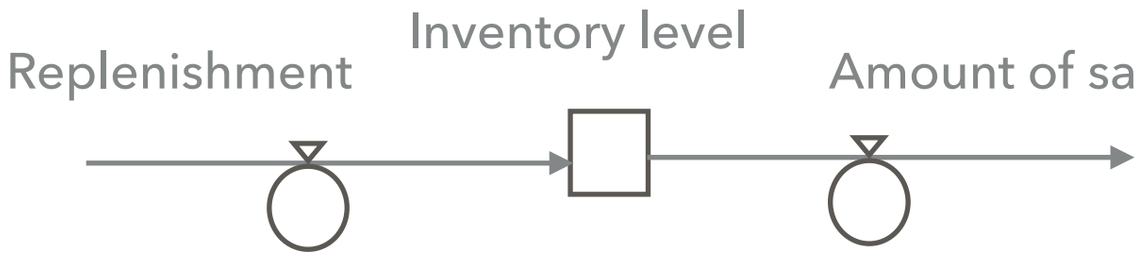
It allows modelling of the system variables and their causal effects on one another which visualises how different variables are interrelated.

Feedback loop: Occurs when a change in something ultimately comes back to cause a further change in the same thing.



Stock and Flow Diagram

It captures the principle of accumulation which states that all dynamic behaviour in the world occurs when flows accumulate in stocks.



DYNAMICS ANALYSIS

Focus on a particular problem represented by a optimisation goal in the BIM schema.
Variables: Indicators influenced by optimisation goal, predictive indicators, proactive action

Map the business assumption about the interaction among the indicators and proactive actions in casual loop diagram

Identify what variables are stocks and what are flows and develop the stock and flow diagram

Assign the mathematical formula to variables in stock and ow diagram which requires a deal of precision around the relationships among indicators and proactive actions.

Identify the key analytics decisions (What data? what algorithm?)

Define what we need to see from the behaviour of indicators to assess the analytics decisions (the indicator with efficient performance?)

Identify uncertainties (most fragile assumptions about the business from inside and outside world associated with the optimisation goal)

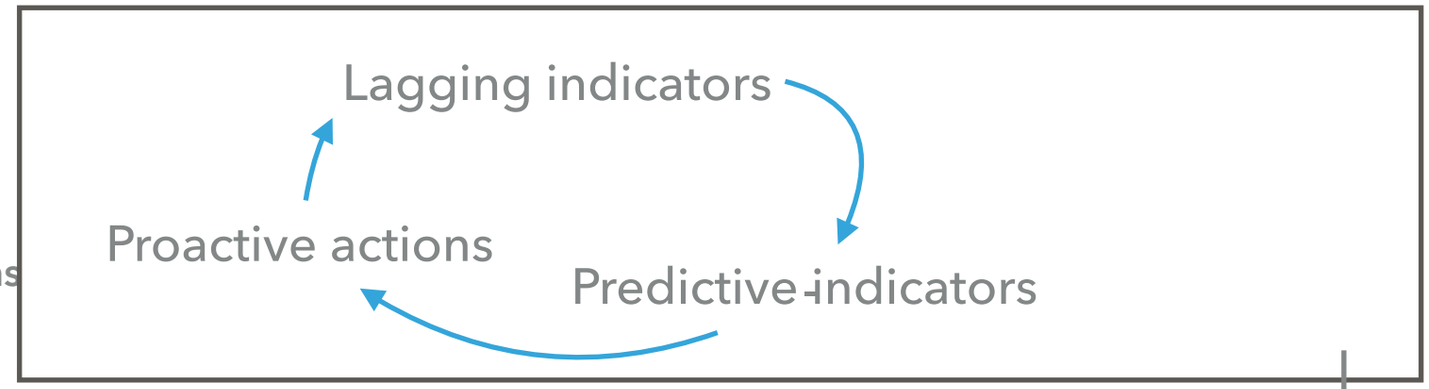
Try out different possible sets of analytics decisions under different assumptions about the domain uncertainties.

SYSTEM DYNAMICS IN DYNAMICS VIEW (INPUT/OUTPUT)

BUSINESS VIEW

Variables: lagging indicators, predictive indicators, proactive actions

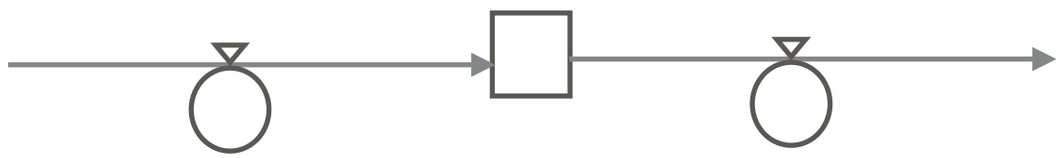
Casual Loop Diagram:



Casual effects among variables

Assign Formula, Identify stock and flow

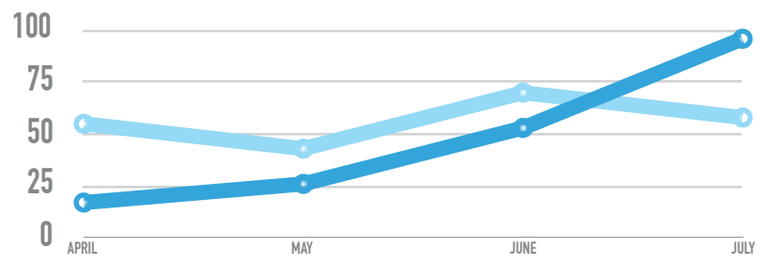
Stock and Flow Diagram



Examine policies

ANALYTICS VIEW

Simulation model



Decision policies:
Prediction strategy

(variables, algorithm)

DYNAMIC VIEW USING SYSTEM DYNAMICS (INPUT/OUTPUT)

Business analyst

BUSINESS VIEW

ANALYTICS VIEW

Business-related concepts as variables

New requirements

Analytics-related concepts as decision policies

Feedback loops, Stocks and flow, Formula for relations between variables

SYSTEM DYNAMICS FRAMEWORK

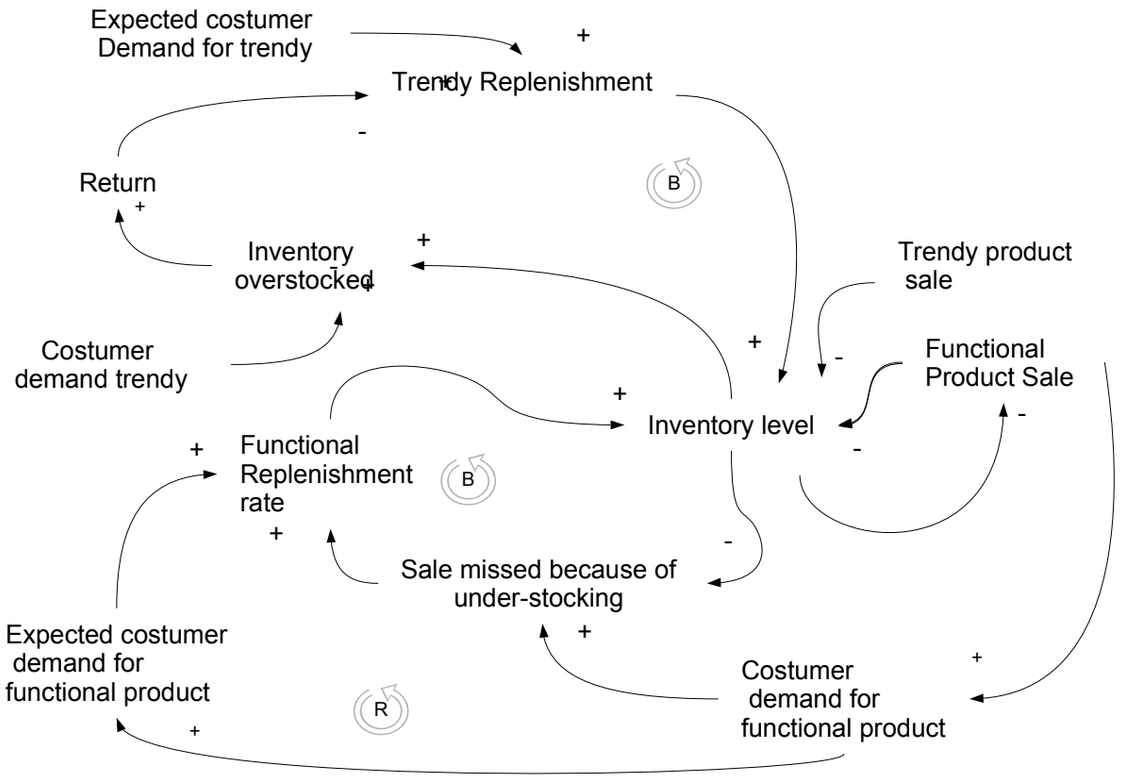
A set of models capturing the dynamic interactions of indicators measuring the influence of predictive indicators on organisational goals

Benefits

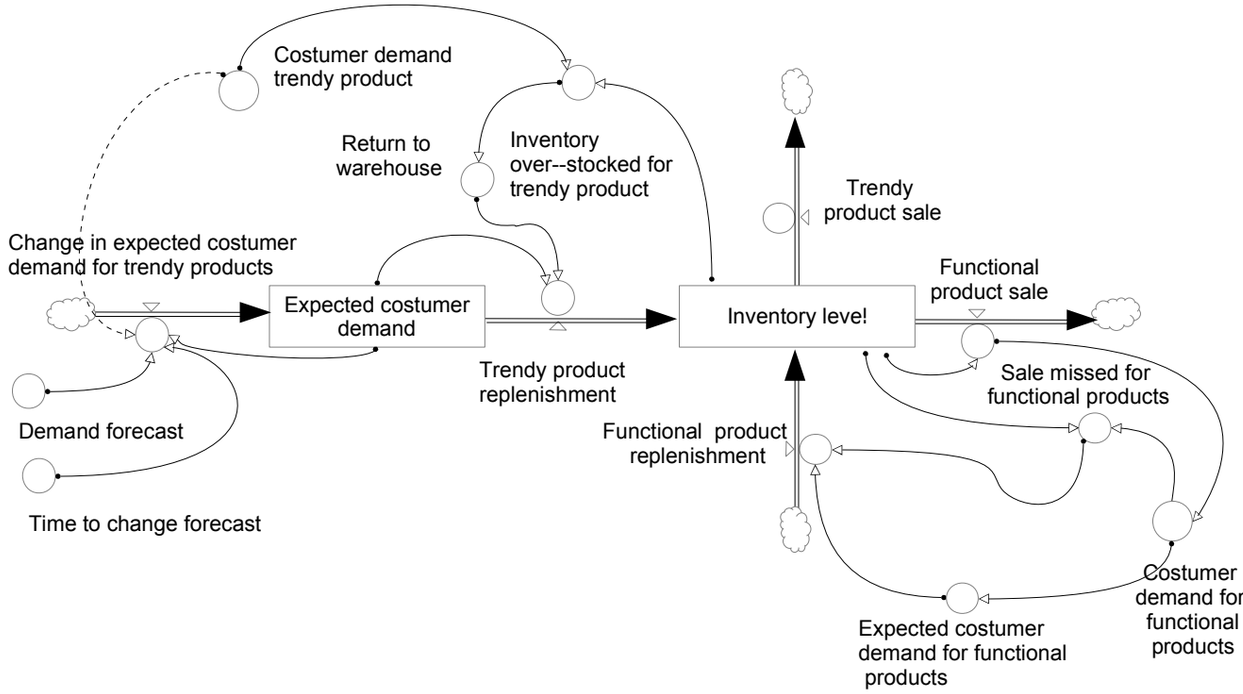
- Provides a way to monitor the impact/value of predictive analytics initiatives on the business
- Facilitates decision making over the alternative analytics approaches as we can examine the influence of various alternatives
- Used to elicit new business and subsequent analytics requirements
- Study indicators as a whole rather than traditional approach to monitoring which study indicators behaviour in isolation

DYNAMICS VIEW

CASUAL LOOP DIAGRAM

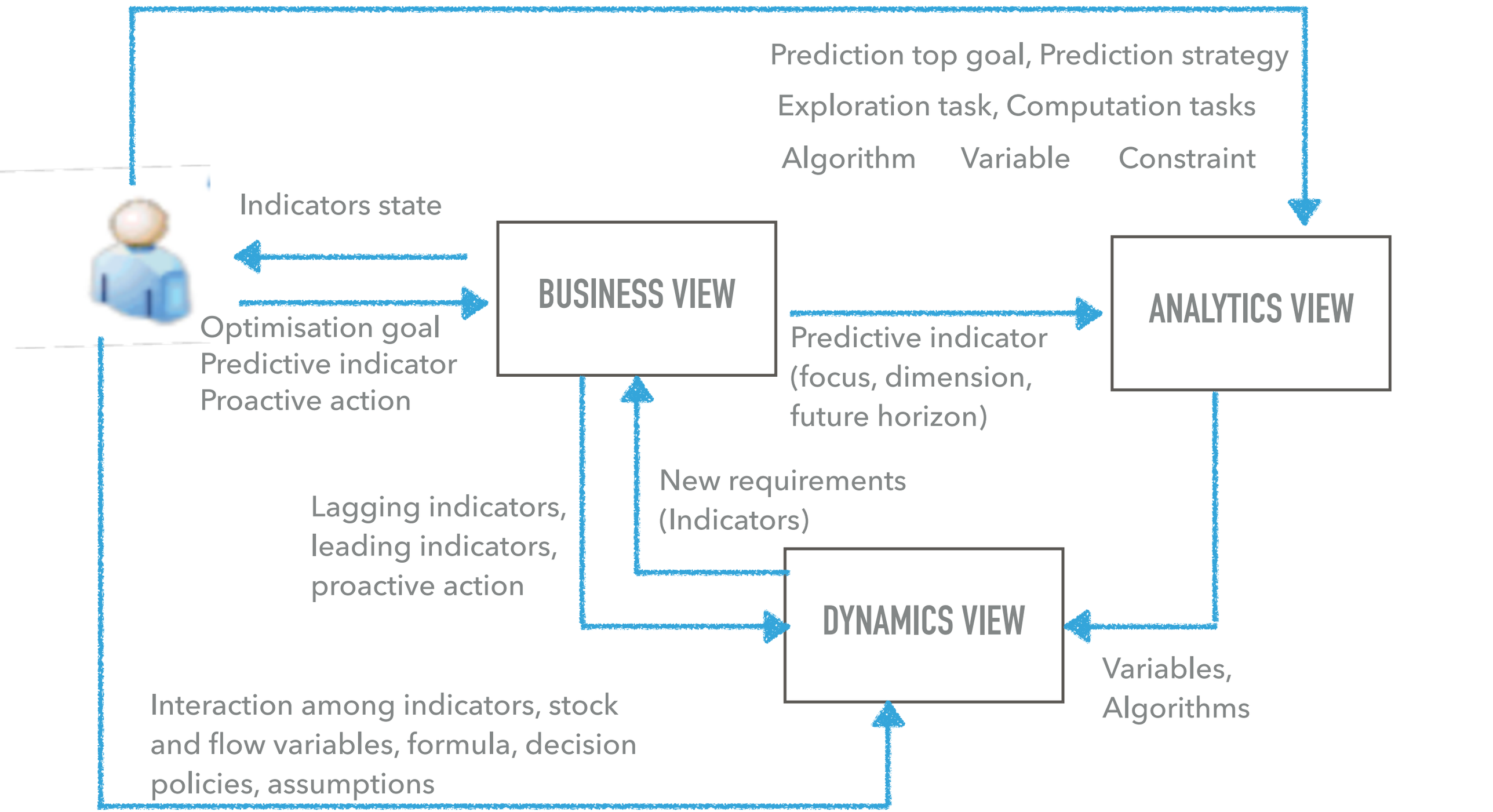


STOCK AND FLOW DIAGRAM



ON PROGRESS

INTERACTION OF VIEWS



RELATED WORK

Indicators in BI solutions

Conceptual modeling for Analytics

System dynamics for Indicators

System dynamics in the context of adaptive enterprise

FUTURE WORK

- The in-depth evaluation of the proposal is an ongoing work and we are conducting a case study in which business users are utilising the proposed framework.
- The framework will be enriched to cover all the components of the **design science methodology**
- The development of a tool that supports the proposed framework

OUTPUT

Nasiri A, Zimányi E, Wrembel R. Requirements Engineering for Data Warehouses, Proceedings of the 11e Journées francophones sur les Entrepôts de Données et l'Analyse en ligne, Brussels, 2015.

Nasiri A, Zimányi E, Wrembel R. Model-based Requirements Engineering for Data warehouses: from Multidimensional Modelling to KPI Monitoring, Proceedings of ER 2015 Workshops, LNCS, Stockholm, 2015.

Nasiri A, Ahmed W, Wrembel R. Zimányi E, Requirements Engineering for Data Warehouses (RE4DW): From Business Strategy to Multidimensional Model, Proceedings of ER 2017 Workshops (Submitted)

Nasiri A, Yu E, Wrembel R. Zimányi E, From Indicators to Predictive Analytics: A Conceptual framework ER

Nasiri A, Yu E, Wrembel R. Zimányi E, Actionable BI with Predictive Indicators (80% completed)